MASTER OF SCIENCE
IN
COMPUTER SCIENCE

GENERIC BLUETOOTH DATA MODULE
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Sensors are being used in many industrial and military applications. The most common ones are temperature and pressure sensors. Communicating with sensors has long been limited either to wired connections between the sensing element and the control station or to expensive, proprietary wireless communications protocols.

The emerging Bluetooth technology enables fast, efficient sensor communication, which eliminates wired connections and the associated manual tasks of initiating, checking, and changing sensor connections. It will be useful for a broad range of data-acquisition, measurement, control, monitoring, and similar applications. Bluetooth products currently available in the market support many usage models such as printer, headset, etc.

This thesis discusses and investigates the feasibility of interfacing sensors with Bluetooth modules by using off-the-shelf components. A prototype interface board was developed and connected to a Bluetooth module. Testing results showed that it is viable to implement Bluetooth-based wireless sensors for shipboard applications.

KEYWORDS: Sensors, Computing and Software, Wireless LAN, PAN, Bluetooth

A COGNITIVE TASK ANALYSIS OF CLOSE QUARTERS BATTLE
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This thesis contains a well-developed, general purpose, descriptive model for the conduct of close quarters battle. Developers of computer-based, cognitive close quarter battle trainers and the military community at large will find it useful as a thorough descriptive model of this complex task. The analysis begins with a thorough description of close quarters battle and includes not only general procedures and methodologies used but perceptual cues as well. The analysis begins at the individual assault team member level and progresses up to the collective activity of a four-man assault team. Four scenarios are presented showing an assault team conducting close quarters battle in increasingly more difficult conditions. The knowledge representation approach utilized is a highly adapted version of the Goals, Operators, Methods, Selection Rules (GOMS). In addition, some new structures are introduced. The accuracy of the model was validated by interviews with close quarter battle specialists having a broad range of backgrounds.

KEYWORDS: Close Quarters Battle, CQB, Cognitive Task Analysis, Close Quarters Battle Trainer

EXECUTION LEVEL JAVA SOFTWARE AND HARDWARE FOR THE NPS AUTONOMOUS UNDERWATER VEHICLE

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Autonomous underwater vehicles (AUVs) have a great potential use for the United States Marine Corps and United States Navy. When performing amphibious operations, underwater mines present a danger for the forces going ashore. The use of underwater vehicles for the detection of this mines and signaling to the Amphibious Ready Group is very attractive. With advancements in hardware and object oriented language technology, more complicated and robust software can be developed. The Naval Postgraduate School Center for AUV Research has been designing, building, operating, and researching AUVs since 1987. Each generation of vehicles has provided substantially increased in operational capabilities and level of sophistication in the hardware and software respectively.

With the advancement in real-time computer languages support, object oriented technology, and cost efficient and high performance hardware, this thesis lays the foundations to develop a software system for the execution level using the Java language.

In this thesis, the Java Real-Time specifications and extension are studied to familiarize with the capabilities of Java for real-time support to autonomous underwater vehicles, and study Java boards and its application for embedded real-time systems. An object-oriented design for the execution level control software of the NPS AUV was developed and the design in Java for a virtual world model was implemented. A testing phase is still under work.

KEYWORDS: Software Engineering, Autonomous Underwater Vehicles, AUV, Java, Java Board, Embedded Java, Real-time Software, Real-time Java, UML

FORWARD OBSERVER PERSONAL COMPUTER SIMULATOR (FOPCSIM)

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This joint thesis addresses the need for a task trainer for the artillery forward observer task. In recent years, declining budgets, limitations on artillery ammunition and encroachment into training areas have reduced the opportunity to conduct live fire artillery training. Simulation systems available to operating forces utilize technology that is several years out of date and none have a deployable configuration. The goal was to develop a proof of concept simulator that uses advanced 3D graphics to replicate the artillery call for fire task. The system utilizes Digital Terrain Elevation Data (DTED) to produce accurate 3D geometry that is further enhanced by the use of color satellite imagery as a texture overlay to produce extremely realistic terrain. The procedures utilized in the FOPCSIM are taken directly from a cognitive task analysis and executed through keyboard, mouse or voice recognition interfaces. The accuracy of these procedures was validated through a series of studies involving military personnel trained as forward observers. A wide variety of mission types, munitions, targets, training areas and environmental effects are available to the user and may be set at the beginning of the simulation or changed during the simulation through a Graphical User Interface.

KEYWORDS: Field Artillery, Forward Observer, Call for Fire, FOPCSIM, Training, Virtual Environment, Fire Support, Close Air Support, Simulation

A METHOD FOR MITIGATING DISTRIBUTED DENIAL OF SERVICE ATTACKS ON DIFFERENTIATED SERVICES NETWORKS

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In this thesis, a method for countering Distributed Denial of Service (DDoS) attacks in networks that provide Quality of Service (QoS) guarantees using Differentiated Service (DS) is presented. Our approach uses feedback from the DS provider to initiate a method of signing packets at the source. This signature allows the DS provider to distinguish valid packets from malicious packets. The feedback mechanism can also be used to provide key management for other digital signature methods, such as the Internet Protocol Authentication Header extension (IP AH). However, unlike other signature methods, our solution requires no encryption or cryptographic processing on a per-packet basis. Instead, it utilizes the sender's ability to alter its packet signature faster than the attacker can duplicate the changes. Our method also avoids the fragmentation and decreased throughput associated with increased packet size of IP AH through use of existing fields in the IP header. The research shows that this method results in a significant reduction in the number of valid packets that are dropped during a DDoS attack. Thus a DS provider would be able to maintain QoS guarantees during an attack without incurring the overhead associated with cryptographic signatures. A C++ implementation of the feedback and signature methods for the NS2 network simulator and the experimental scripts used in the simulator are included as appendices.

KEYWORDS: Differentiated Service, DiffServ, Distributed Denial of Service, DOS, DDOS, Quality of Service, QOS, NS2

VISUAL META-PROGRAMMING LANGUAGE GRAPHICAL USER INTERFACE FOR GENERATIVE PROGRAMMING

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A Visual Meta-Programming Language allows the user to see a graphic representation of the data flow between components. Like the visual programming concepts for common programming languages in use today, this language makes it easier to build software by putting together graphical elements that correspond to larger and more complex pieces of code.

This research will develop the implementation of a visual meta-programming language graphical user interface for program generation. The objective is to create an interface that represents programming data flow using the visual meta-programming language, allows the user to add, modify, and delete elements of the program, and generates formatted output that can be used by generative programs to produce code. Areas of study will include efficient data structure design to capture the nature and characteristics of visual elements of the language and translation of visual design to a format suitable for use by other programs.

KEYWORDS: Meta-Programming, Visual Language, Data-Flow, Graphical User Interface

A METHODOLOGY FOR STATE AND TRANSITIONAL ANALYSIS OF THE M1A2 ABRAMS DRIVER'S INSTRUMENT PANEL

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This thesis is an independent study to conduct a detailed problem analysis in order to determine if a methodology can be derived to map the states of the M1A2 simulator to specific doctrinal tasks. Specifically, what are Tactics, Techniques and Procedures (TTP), Crew Drills, and Battle Drills and can they be mapped to specific states of the M1A2 simulator? If such a mapping exists, then demonstrate the methodology using a small subset of the M1A2 simulator stimuli and a given doctrinal task. Additionally, can we identify problem areas associated with state to task mapping, such as 'state explosion' and recommend a possible solution. Through the research, it is concluded that a methodology can be derived and demonstrated that it is reasonable to accept input in the form of stimuli from the driver's instrument panel, evaluate current state and anticipate future states within the context of a given tactical or training scenario.

KEYWORDS: State Explosion, State and Transitional Analysis, M1A2 Driver's Compartment

REASONING BY ANALOGY USING HOLOGRAPHIC CONCEPTUAL PROJECTION

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This thesis discusses the designing of an architecture which mimics a human thought mechanism. The architecture is called a Holographic Conceptual Projection, which uses analogy and dynamic pattern matching combined with some natural-language understanding. The main hypothesis is to project a way of thinking into words and sentences which can be manipulated when thinking verbally. This means that the structure of sentences can be exploited to build an algorithm that models the thought mechanism. In the Holographic Conceptual Projection Architecture, examples are given of every word within the context patterns. The patterns contain sentences that describe the "condition," "desired situation," "proposition," and "outcome" of the concept. The concept's patterns are then compared with new cases to see analogies. This comparison is done with dynamic generalization and specialization techniques. Finally after building an implementation, it is tested on an intelligent file-management system and an image-processing application.

KEYWORDS: Artificial Intelligence, Reasoning by Analogy, Conceptual Projection, Means-Ends Analysis, Linguistics

ENHANCEMENT OF LEARNING PROCESS IN WEB-BASED COURSES USING COMBINED MEDIA COMPONENTS

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Web-based courses are a popular form for applying distance education today. The development of the educational environment for applying these kind of courses is often considered an art form. Two approaches were studied for the development of a part of a web-based course. The first is the instructional design approach and how an instructor will implement the best course possible applying the more suitable instructional strategies. The second is how these instructional strategies will be adapted to the web for the creation of an educational environment that will enhance the learning process. Combined media components were used, animations and movies, to study the added value of these components to the instructional strategies. The course was delivered to a number of students who evaluated the result. The evaluation assessed the course for both the instructional quality and the web site design and usability. The scope is to study how to develop a high quality web-based course and to determine if the combined media components added value to the educational result. It is believed that this study will help create the knowledge base for the planning and development of web-based courses for the personnel of the Hellenic Navy.

KEYWORDS: Distance Learning, Web-based Instruction, Combined Media Components, Instructional Design, Web-based Course, Pedagogy, Usability, Web Site Design, Multimedia, Online Courses

AN EVENT-TRACE LANGUAGE FOR SOFTWARE DECOYS

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Cyberspace is becoming the battlespace of the future, and military practices, like deception, seem to be suitable for defending information systems from attacks. In this thesis, the concept of intelligent software decoys, which employ a form of software-based military deception, is explored.

A prototype of a high-level language for specifying intelligent software decoys was developed. The approach involves two stages. The specification language is intended to be part of a high-level user interface, making the implementation details of software decoys transparent to the information warrior. A case study is provided in which the utility of the specification language for specifying software decoys to counter a real-word attack program is demonstrated.

KEYWORDS: Computer Security, Event-Trace Language, Intrusion Detection, Deception

INTEGRATED THEATER ASSESSMENT PROFILING SYSTEM

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The Integrated Theater Assessment Profiling System (iTAPS) takes the original stove-piped Theater Assessment Profiling System (TAPS) software solution and turns it into a robust, data-centric, web-based decision support system for Commander, Second Fleet. ITAPS uses the .Net Framework and ASP.NET/ADO.NET, along with SQL Server to provide a web-enabled application that gives an overarching, abstracted view of the battle space for the Operational Commander while still providing drill-down capability and trend analysis tools if more detail is desired. The software was developed using the extreme programming technique and black box testing methods. A demonstration was performed at Second Fleet to test its acceptability and usability.

KEYWORDS: Decision Support System, .NET Framework, Radar Diagrams, Theater Assessment

AUTOMATIC TEXT CATEGORIZATION APPLIED TO E-MAIL

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The author developed an automatic text categorization approach and investigated its application upon categorizing emails. The categorization approach is derived from an instanced-based learning method that explores conditional probabilities of particular words. The effectiveness of the author's categorization approach using collections from a set of emails is then evaluated and assigned a numerical score based upon precision and recall. Precision was 65% while recall was 17%. The author's experiments indicated automatic categorization of incoming emails at the client level can categorize email, but is difficult when not using a standardized corpus. Word frequency is valuable, but should be used in combination with other methods such as phrase extraction for a higher level of performance.

KEYWORDS: Text Categorization, Automatic Classification, Java Text Processing

DELAYING-TYPE RESPONSES FOR USE BY SOFTWARE DECOYS

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Modern intrusion detection systems have become highly reliable in identifying a malicious user on a computer system. Their limitations, though, are increasing the need for an intelligent response to an intrusion. In contrast, intelligent software decoys provide autonomous software-based responses to identified intrusions. In this thesis, conducting military deception is explored, focusing on the use of software-driven simulations to respond to the actions of intruders. In particular, this thesis focuses on a model of a simple deceptive response that is intended to protect a search-type program from a buffer-overflow attack. During our study, it was found that after identifying an attack attempt, simulating system saturation with processing delays worked well to deceive a prospective attacker. Experiments were also

conducted on providing confusing reactions to an identified attack attempt, such as simulated network login screens and fake root-shells. The results were successful, simple reactions to intrusions that mimicked intended system interaction, and they proved to be adequate at implementing the deception principles we studied.

KEYWORDS: Intelligent Software Decoys, Intrusion Detection, Computer Deception, Decoy Response, Military Deception, Simple Deceptive Response

A RENDERING SYSTEM INDEPENDENT HIGH LEVEL ARCHITECTURE IMPLEMENTATION FOR NETWORKED VIRTUAL ENVIRONMENTS

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The High Level Architecture (HLA) is the Department of Defense standard for networking virtual environments. This thesis implements a modular HLA component that can be used independently from the graphics-rendering engine used by the programmer. The modular design of the HLA component allows programmers of virtual environments to rapidly network their existing standalone virtual environments using the DOD standard networking protocol. The HLA component is being used to build a networked virtual environment compatible with Joint Semi-Automated Forces (JSAF). This networked virtual environment will allow a group of human controlled simulations to interact with JSAF controlled entities over common terrain. Complete C++ implementation code is included as an appendix.

KEYWORDS: High Level Architecture, HLA, Networked Virtual Environments, Joint Semi-Automated Forces, JSAF

A PEER SHARING APPROACH TO MISSION PLANNING AND DEVELOPMENT IN U.S. ARMY TACTICAL ENVIRONMENTS

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This thesis analyzes the technical and information management environment that United States Army heavy combat tactical units operate in and provides a solution for how the Army's software development community can assist these units in managing multiple sources of information. The computer hardware, software applications and network infrastructure are examined within this context to illustrate the difficulty that lower level tactical units face in receiving, processing and redistributing information in an automated environment. The thesis describes some of the systemic reasons, not readily apparent to higher level operational units, as to why lower level tactical units struggle to keep pace with all of the information they received. Platform-centric, stovepipe approaches have caused significant challenges for managing the flow of information to and from the tactical unit level. In addition, the pushdown approach to information distribution does not adequately address how the terminal level units in the distribution process receive and synthesize information from multiple sources.

KEYWORDS: Information Management, Push-Pull Information Retrieval, Peer Data Sharing, Mission Planning and Development

A NOVEL APPROACH FOR THE SIMULATION AND MODELING OF STATE-OF-THE-ART MULTIJUNCTION SOLAR CELLS

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In this thesis, a new method for developing realistic simulation models of advanced solar cells is presented. Several electrical and optical properties of exotic materials, used in such designs, are researched and calculated. Additional software has been developed to facilitate and enhance the modeling process. Furthermore, specific models of an InGaP/GaAs and of an InGaP/GaAs/Ge multi-junction solar cells are prepared and are fully simulated. The major stages of the process are explained and the simulation results are compared to published experimental data. Finally, additional optimization is performed on the last state-of-the-art cell, to further improve its efficiency. The flexibility of the proposed methodology is demonstrated and example results are shown throughout the whole process.

KEYWORDS: Solar Cell, Multijunction, Material Parameters, Tunnel Junction, Model, Simulation, Development, Silvaco

XML BASED ADAPTIVE IPSEC POLICY MANAGEMENT IN A TRUST MANAGEMENT CONTEXT

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TCP/IP provided the impetus for the growth of the Internet and the IPsec protocol now promises to add to it the desired security strength. IPsec provides users with a mechanism to enforce a range of security services for both confidentiality and integrity, enabling them to securely pass information across networks. Dynamic parameterization of IPsec further enables security mechanisms to adjust the level of security service "on-the-fly" to respond to changing network and operational conditions. The IPsec implementation in OpenBSD works in conjunction with the Trust Management System, KeyNote, to achieve this. However the KeyNote engine requires that an IPsec policy be defined in the KeyNote specification syntax. Defining a security policy in the KeyNote Specification language is, however, extremely difficult and the complexity of the language could lead to incorrect specification of the desired policy, thus degrading the security of the network. This thesis looks into an alternative XML representation of this language and a graphical user interface to evolve a consistent and correct security policy. The interface has the simplicity of a simple menu-driven editor that not only provides KeyNote with a policy in the specified syntax but also integrates techniques for correctness verification and validation.

KEYWORDS: KeyNote, ISAKMP, IKE, IPsec, Graphical User Interface, Security Assoication (SA), Security Policy Database (SPD), XML, XSLT, DTD, Schema, JDOM, SAX, Security Policy

VIRTUAL CLOSE QUARTER BATTLE (CQB) GRAPHICAL DECISION TRAINER

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The physical skills exhibited by Marines conducting CQB operations are a reflection of their cognitive adaptation and performance while in that environment. While these physical skills require continuous reinforcement for the Marine to remain effective, so does the Marine's ability to make rapid and sound decisions according to Marine Corps CQB Doctrine. During extended periods at sea, Marines are currently afforded little or no practical application of these skills due to a lack of proper facilities aboard ship.

The Virtual CQB Graphical Decision Trainer (VCGDT) fills this void. VCGDT provides an interactive virtual environment where Marines can communicate both verbally and non-verbally; and coordinate training activities and simulated missions. In addition, the system promotes the introduction of team leaders and instructors into the environment for real-time virtual supervision and instruction.

The VCGDT hardware design takes into consideration the size and bandwidth constraints posed by placement on a Naval vessel. Additionally, the VCGDT attempts to circumvent problems associated with some types of tracking systems due to ship composition and radar; and locomotion devices due to excessive ship motion.

KEYWORDS: Virtual Trainer, Virtual Environment, Close Quarter Battle, Virtual CQB, Marine Trainer, Dismounted Infantry, Cognitive Training

ENTERPRISE IMPLEMENTATIONS OF WIRELESS NETWORK TECHNOLOGIES AT THE NAVAL POSTGRADUATE SCHOOL AND OTHER MILITARY EDUCATIONAL INSTITUTIONS

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The purpose of all information systems is to assist people in transitioning data into information, and then information into knowledge. In order to reach IT modernity, three things need to occur: a convergence of single open platform data exchange (e.g., Extensible Markup Language (XML)), the development of new doctrine to manage this information (e.g., Net Centric Warfare), and the creation of a robust mobile secure network (e.g., 802.11). The heart of this research will focus on the last element.

Future wars will be fought using wireless mobile networks. Wireless research is being realized at the Naval Postgraduate School (NPS) Wireless Warrior Group. The Wireless Warrior Group is designing and implementing the new unclassified wireless network at the NPS using the IEEE 802.11 standard. The Wireless Group was founded by the author of this thesis and is currently made of 150 members consisting of staff, faculty, and students from a variety of different curriculums.

The purpose of Wireless Warrior is to develop the doctrine of wireless networking by making it a part of every student, staff, and faculty daily communication and production. Only through constant scrutiny and use can real solutions emerge. The entire campus becomes a computer lab. Wireless Warrior provides a fertile ground for students to write new applications, to communicate and collaborate in ways unthinkable just a few years ago. Wireless computing does to computers what the cell phone did to the wired telephone. It is an educational and operational force multiplier. Wireless mobility is the future of warfare, and usable, supportable, secure mobile communication is what wins wars. This thesis documents the NPS journey into the wireless domain.

KEYWORDS: IEEE 802.11, Wireless, Local Area Networks, Educational Network Design, Campus Networks

ACHIEVING LAST-MILE BROADBAND ACCESS WITH PASSIVE OPTICAL NETWORKING TECHNOLOGY

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One of the primary challenges in today's computer networking world is providing enough bandwidth to achieve true broadband access in the local, or last-mile, access network. Over the course of the last decade or so, there has been a tremendous increase in the bandwidth of the core network in the U.S. In fact, a substantial portion of this core network, which primarily consists of fiber optic technology, is unused. This is primarily due to the lack of bandwidth in the last-mile access network. The last-mile access network of today primarily consists of technologies (e.g. digital subscriber line and cable modem access) that rely on infrastructures designed to carry voice and cable television signals. As a result, consumers are not able to enjoy true broadband services.

This thesis discusses and analyzes the use of passive optical networking (PON) technology as possibly the best solution to today's last-mile bottleneck. General PON technology concepts and details concerning the two primary PON technologies, asynchronous transfer mode (ATM) PONs and Ethernet PONs, are discussed. The application of PON technology in achieving fiber to the home, using both PON-only and PON-hybrid infrastructures, is also described. Finally, the current PON business market and regulatory factors are discussed and analyzed.

KEYWORDS: Passive Optical Networking, Broadband Internet Access, Last-Mile Access, Fiber Optical Networking

SEMANTIC AND SYNTACTIC OBJECT CORRELATION IN THE OBJECT-ORIENTED METHOD FOR INTEROPERABILITY

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In today's military interoperability is not a luxury, it is a necessity. Unfortunately, differences in data representation between various systems greatly complicate the task of achieving interoperability between them. Young's Object-Oriented Method for Interoperability (OOMI) describes a model-based, computer-aided methodology for resolving modeling differences among heterogeneous systems in order to enable system interoperability. The OOMI architecture and tool suite provide a high level of automation that will reduce the labor and complexity of integrating heterogeneous systems into a cooperative system of systems (federation of systems). The Component Model Correlation process in the OOMI architecture describes a methodology to correlate a component systems model of a real-world entity to the federation model of the same real-world entity. Once a correspondence is established, the OOMI tool suite facilitates the construction of wrapper-based translations between the component model and the federation model. These translations are then used in a run-time translator to enable interoperation between the federation of systems. This thesis describes the Component Model Correlation methodology and presents a prototype Component Model Correlator that assists an Interoperability Engineer in determining component model correspondence.

KEYWORDS: Interoperability, Component Model Correlation, Semantic Correlation, Syntactic Correlation, Heterogeneous Software Systems, XML, Neural Networks, Java

TELECOMMUNICATIONS TECHNOLOGY AND SERVICE CHANGES AFTER THE TELECOM ACT OF 1996

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The Telecom Act of 1996 was intended to address the lack of competition and reduce regulation in local telephone services and in other areas of the telecommunications sector. The competitive situation in telecommunications, particularly regarding local telephone services, has experienced a limited amount of positive change as a result of the Act. Local Telephone service consumers are still given little choice as the Regional Bell Operating Companies (RBOCs) continue to dominate coverage in the local loop.

The purpose of this thesis is to demonstrate the effects that the situation resulting from the Act had on the expansion of telecommunications options and the emergence of new technologies. This thesis also focuses on exploring to what degree competition in telecommunications has improved since 1996. Case studies of telecom companies are utilized to demonstrate how effective the regulations of the Act were in various telecom areas such as long-distance and local services. The convergence of technologies and applications is also identified as several providers combined to offer services such as Web hosting, Voice Over IP solutions, wireless, and long-distance. Problems such as the need for new networks in the local loop are identified and recommendations for potential solutions in the telecom industry are also given.

KEYWORDS: Telecommunications Act of 1996, Regional Bell Operating Company (RBOC), Competitive Checklist, Universal Service, Facilities-Based Competition, Long-Distance Service, Voice Over IP, Competitive Local Exchange Carrier (CLEC)

ANALYSIS AND PROTOTYPING OF THE UNITED STATES MARINE CORPS TOTAL FORCE ADMINISTRATION SYSTEM (TFAS), ECHELON II – A WEB ENABLED DATABASE FOR THE SMALL UNIT LEADER

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This thesis analyzes the requirements and development of a prototype web site for the United States Marine Corps' Total Force Administration System (TFAS), Echelon II – A Web Enabled Database for the Small Unit Leader. The analysis consisted of researching the characteristics of the current manpower system, MCTFS, and the conceptual tenets of the TFAS program. The thesis presents relevant background information on MCTFS, TFAS, and then gives a detailed presentation of system and user functional requirements for TFAS, Echelon II. A detailed system architecture for the TFAS, Echelon II web site prototype and its integration with MCTFS are presented. Specifications are enumerated for a multi-tiered web-enabled application integrated with a system of distributed synchronized databases. Additionally, sample programming code for implemented web site functionality is explained, in conjunction with screen shots of the working prototype. The examples include user identification and data query binding at run-time. Samples of read-only reports and data entry tasks whose data is confined to Marines within the TFAS user's unit are explained. Programming is shown for data entry tasks along with a presentation of how this data is transformed into XML "Unit Diary" files, which are generated dynamically. A migration path is described for the integration of the current web technologies with legacy manpower systems. Finally, conclusions and recommendations derived from the thesis work are presented to aid TFAS planners and developers in moving TFAS from a concept to an operational system.

KEYWORDS: TFAS, Total Force Administration System, MCTFS, Marine Corps Total Force System, Web-enabled, Relational Database, Distributed Databases, Manpower Systems, XML, Extensible Markup Language, Multi-tier Web Application